Vol. V. No. 50 JULY, 1941

Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

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Films of Clay

THREE months ago we wrote an editorial with the somewhat provoking title "Revenge," in which we related that while we and the plastics industry as a whole were hugging ourselves that we had "put a fast one" over the metallic and inorganic world with those remarkable offsprings of organic chemistry called plastics, yet now and again we can receive shrewd and hard blows from those who are in what we sometimes think of as the opposite camp. It was in reality an exhortation not to get swelled heads and not to slow up for one moment our research work on producing new and better plastics.

We referred to the work of two persons in the Massachusetts Institute of Technology, named Le Beau and Hauser, on the colloidal clay called bentonite, which many readers may know as a useful suspending agent in paints, as a filler, etc. We ourselves have been interested from a physical point of view in this material which has the strange property (when mixed with water) of being thick when "still" and as thin as water when stirred. Le Beau and Hauser have succeeded in making this powdery clay material into sheet form. It may yet replace mica or paper, so the enormous significance of this work is apparent. And if we consider paper alone we can remember that whereas in its raw form, timber, paper takes 30 to 50 years to grow, the clays of the world are ready to be mixed and treated. Exploitation of such a process would be the greatest blow the wood pulp industry has yet received. However, we have no right to assume that all types of paper could be replaced by bentonite sheet.

Others may consider that of greater and more immediate importance is the disclosure that a real substitute for mica and other electrical insulation is aimed at. How this will affect the plastics industry, or rather that section of it that provides thin dielectric films and sheets, remains to be seen.

Our personal interest in the matter was increased by the belief that this Dr. Hauser was the same who entertained a large number of British rubber chemists in Frankfurt some ten years ago and showed the late Virgil Cox (Secretary of the Institute of the Rubber Industry), Fred May (the famous cartoonist on the "Illustrated Sporting and Dramatic News") and the Editor of this journal, the bright spots of that very bright town. On page 140 of this issue we reproduce a letter from Dr. Hauser in which he admits being the same person. The addition of the very non-professional "Thumbs up" tells us that it is certainly he. We send him our sincere congratulations and best wishes. On page 140 we also reproduce a photograph of his letter. The blackened edges indicate where we have put it into the hot flame of a Bunsen burner. This paper, although it blackened, did not burn, and non-inflammable paper is by way of being a phenomenon even in these remarkable days. Thumbs up! to you, Dr. Hauser.

The Invisible Aeroplane

THE pendulum not only swings back but almost full circle. This month we have pleasure in publishing, on page 141, a letter from Mr. Wallace Bars, the well-known managing director of Cellon, Ltd., whose memory regarding the use of cellulose acetate before and during the last war is longer than most people's.

The German invisible aeroplane, described in our June issue as making its appearance in 1917, was thus later than the French one made of Sicoid cellulose acetate by four years; we are, however, very puzzled as to (1) why a transparent aeroplane should be made in peace time and (2) why, if it was intended for purely military purposes, it was not kept a deadly secret. It seems also strange, if Sicoid was made in France under licence from Rheinisch Westfalishe Sprengstoff A.G., that Dr. Eichengrün should belittle the value of Sicoid, which obviously was being widely used. He must have laboured under the same delusion that affects all Germans to-day—the curious belief that if it's German it's better than anything else. Or perhaps it was another attempt at mass hypnotism. At any rate it was a strange attitude for a scientist to adopt.

To return to our invisible aeroplane. We have now irrefutable proof that both France and Germany made such aeroplanes, for very good reasons, both before and during the last war. One day, perhaps we shall find somebody who flew them who will tell us stories

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about them, and whether they proved of real value.

But, if the idea of the invisible aeroplane is a sound one, and we believe it was and still is a good proposition, how is it that nobody has resuscitated the idea? The obvious retort may be that it was not so brilliant. Unless this is proved we lean to the suggestion that like many other ideas, when everybody was sick of war, it was pigeon-holed and lost. Now that all aircraft, with the exception of a very few, are of metal, the mind cannot easily revert to cellulose acetate.

Heaven forbid that we should suggest a Spitfire or a Catalina flying-boat of transparent plastics. They would probably break in two before they left the ground. But we should like the Minister of Aircraft Production to order one or two made just like an old B.E. 2c. or, better still, an old F.E. The latter with its tail-booms was almost invisible without a cellulose acetate nacelle. A modern 70 h.p. engine would probably do the same work as the old 90 h.p. R.A.F. and 120 h.p. Beardmore engines which drove these machines. All we want is a little machine that need not go at more than 80 to 90 m.p.h. but would just sit invisible and in peace over the enemy coast taking a few photographs.

J'accuse

MANY years ago we came across a curiously named disease, common in French military circles—Système D. It is curiously named but not rare. It was common in the British, American, German or any other army you choose; it is common in any Government controlled organization and strongest in Civil Services. Système D took its name from " se débrouiller " which by devious ways came to mean " to wangle," " never take the blame yourself," " never take the responsibility." The system is always present when men are (a) lazy or (2) afraid of their jobs or (c) secure in their jobs even though the heavens fall.

Now we shall probably be sworn at pretty heartily, but we say unequivocally that in this country, the system is spreading far too much to our liking in industry itself—some will say that it has always been there. We say it is growing steadily and is a very positive danger to the position of this country as an industrial entity in a very industrial world, for this disease brings with it others that retard our progress.

Système D, conservatism, disbelief in the value of research, unwillingness to try new ideas—we suppose they have all the same roots. " What was good enough for my grandfather . . . " is still often an industrial motto although the expression used is somewhat different in form. There is also the strange reluctance even to test a new thing or to accept its value unless it has been tried thoroughly by somebody else. It is the experience of every salesman in the country that British buyers and industrialists almost invariably ask " Where has it been tried? " And if it hasn't been tried, it is almost as invariably turned down. If only the salesman can say that a competitor has used it, it is often accepted. What a strange confession of ineptitude!

There is surely a close connection between this attitude and the attitude taken by industry as a whole towards research, both pure and applied. As a nation, Great Britain simply does not believe in its value and certainly not in " long-term " research. With the exception of the chemical and electrical industries, the number of concerns that regard the spending of money for such purposes in a proper light and allocate a definite amount to forward expenditure can be counted on the fingers of very few hands.

All these thoughts come to us after reading the report of the appeal by Lieut.-Col. Moore Brabazon, Minister of Aircraft Production, to the Institution of Automobile Engineers. In an effort to rouse them to action and to produce more efficient motorcars he said, " Most of the English small cars, developed to a high state of perfection as they are, are not in the same street from the point of view of holding the road and general stability with the products of some of our foreign competitors."

This is slating the British motorcar industry with a vengeance. But why try to soft soap the manufacturers by saying " . . . developed to a high state of perfection as they are . . ." ? How can they be when they are not "in the same street" ? It may be true that the best steel is used and the turning of the cylinders is superb—but there are no new or original ideas behind it all. The motorcar industry is one example among many, and unless it stops copying American and other countries' ideas long after they have been discarded by their originators and do some real thinking and development, then there is a sad outlook after the war.

On looking through the pages of the American journal " Modern Plastics " of May, 1941, we find the following two messages to the Editor.

" Henry Ford tells us:—' We will make the entire superstructure of an automobile, except the tubular welded steel frame, of fibre plastic and the first experimental model will be finished this winter.' "

"Glenn L. Martin (of Glenn L. Martin Co.) tells us:—' I predict that plastics will play an increasingly important part in the future of the airplane. and that we shall see spectacular results within the next two or three years. I believe that their ultimate use will bring closer together those uncongenial old factors—strength, lightness and low cost—so critical in the airplane industry. Interesting applications of plastics are already being made in airplane construction to-day and there are immediate prospects of more important uses. Results obtained through the Glenn L. Martin Fellowship in Plastics at the Mellon Institute and researches in our own laboratories are already bearing fruit beyond our original expectations. The horizon in this field seems all but unlimited.' "

What wonderful encouragement these two great figures in American industry give the plastics industry. Is there a single motorcar or aircraft manufacturer in this country who has given his whole-hearted support to plastics? We doubt it. We even doubt that they have heard of the Mellon Institute. One large British concern that did carry out some desultory experiments on plastics has now given them up and seems no longer interested.

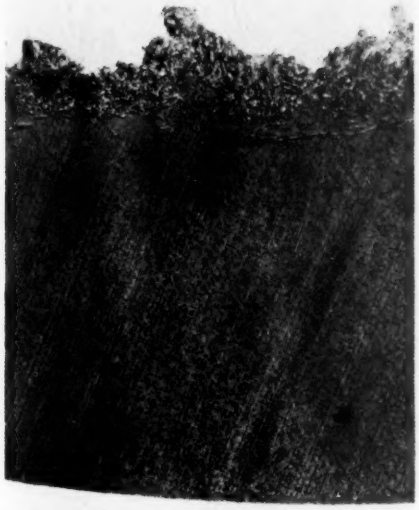
Is there a British manufacturer that can talk in the same language that Ford uses? We doubt it. Mr. Ford has long been ahead of us and his freshness of mind, his eagerness to search for new materials and new designs will keep him there.

Indeed, we are living very dangerously.

PLASTICS IN AIRCRAFT EXHIBIT.—The Society of British Aircraft Constructors, Ltd., will be holding an interesting exhibition of components used in the production of aircraft on July 23 and 24 next at Grosvenor House, London. Admission will be restricted.

New Plastic Developments in the Fur and Shoe Trades

By
H. K. WOOD



(Left) Cross-section of composition sole showing solid nature of the material.

(Right) Cross-section of sole leather made from American tanned hide.

While we have always admitted the truth of the slogan "There is nothing like leather" yet there appears to be a considerable movement afoot to improve upon it

PLASTICS and fur appear to have very little in common with one another, and without prior knowledge it would be difficult to conceive of any possible association between two materials so diametrically opposed, both in origin and characteristic properties.* Yet, strange as it may at first appear, science has now evolved a process whereby plastics can be utilized to increase the life and enhance the beauty of all types of fur, from the humble rabbit to the costly silver fox. The U.S. Patent Office has recently issued a patent to Sigfried Gottfried covering a process for improving the hairs of furs and pelts, which in part constitutes the step of impregnating the hairs with a substance capable of forming water insoluble condensation products, and steaming and ironing the impregnated hair so as to complete the polymerization of the plastic and render it chemically inert and completely insoluble. Both phenolic and urea plastics can be utilized for this process, but urea appears to be the most promising because its condensation products are freely soluble in water and are both colourless and odourless. In effect, this new process appears to closely resemble the familiar method of producing a crease-resisting textile material, but with the fur impregnation special steps have to be taken to ensure that the natural beauty and softness of the fur are not in any way adversely affected. It is claimed that the new method can be successfully carried out after dyeing and that its application offers wide scope to the practical furrier.

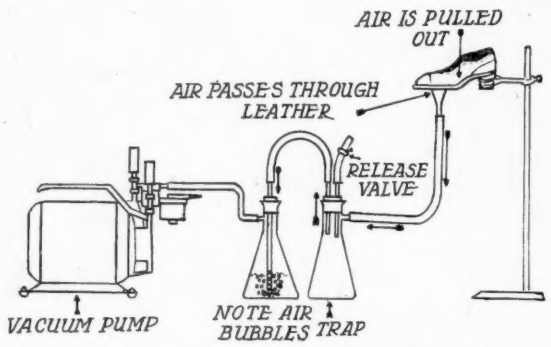
Turning from fur to footwear one is confronted with a number of very interesting and potentially important developments affecting almost every branch of the trade. Take, for instance, the plastic heel. Hitherto the main difficulty about this novelty has been to adapt it to standard shoe-making machinery as the nails would only go into certain fixed holes. This difficulty has now been overcome by one of the leading American manufacturers catering for the shoe trade. The new plastic heel has embedded in it a wooden core, so that the top of the heel is practically the same as the standard wooden heel. Leather or composition lifts may be attached to the heel and replaced as needed after wear. The heel is attached to the shoe in the same way as the ordinary non-plastic type, and this is a very great advantage to the manufacturer as regards ease of production and ultimate output. Plastic buckles, fabricated of acetate, are also available and many striking colour combinations are made available for the fashionable women's trade. Plastics are also being increasingly used in the manufacture of corrective footwear. A new American invention for deformable foot support for shoes comprises an envelope, a thermoplastic filler retained by said envelope and heating means within the envelope. Shoes with soles of synthetic rubber have

*Editor's Note.—On the contrary, we believe there is much akin between plastics and a protein or keratin substance that is probably extruded under pressure through tiny holes in the skin.

now been tested in 27 different industries where oil, heat, acids, caustics, blood, gasoline, grease, crude oil, etc., were present. Preliminary reports of these tests in actual service indicate that the synthetic rubber soles would outwear other materials from two to five times, depending upon the service. Safety advantage is also claimed for this type of sole on work shoes as traction can be increased.

Non-spark safety shoes with soles either partially or wholly made of thermoplastics, particularly the new vinyl resins, are now in use experimentally in explosive plants and also in electrified mines where the danger of transmitting current by means of ordinary footwear is known to be considerable.

In the manufacture of modern rope soles plaited from tough, resilient and perfectly cleansed Indian jute, the soles are now chemically treated with enough latex to give them a water repellent quality. It has been suggested that the jute might be made even more water repellent by treating it with a urea condensation product and then steaming and hot pressing the lightly centrifuged and yet thoroughly impregnated material. Incidentally, rope-soled footwear is in great demand in the Near and Far East and, in normal times, it sells very well in this country for beach use.



Diagrammatic illustration of the apparatus used by Dr. F. O'Flaherty (American Tanners' Council Laboratory), which demonstrates the ventilating property of any material. The funnel attachment on the shoe is held by suction and can quickly be changed to any other material to be tested.

Plastics have recently been suggested for use in the construction of very special types of footwear, such as those designed to give the wearer extra protection against wet or cold. What are technically known as heavy duty boots, that is, farm boots and footwear used by log drivers on the rivers that wind through the mountains of Maine and Canada to the sea, need very special treatment to ensure that the water does not penetrate. Dispersions of acrylic resin are said to be the most satisfactory for this particular type of leather.

Before turning to the future and predicting new applications of plastics in the manufacture of footwear it is as well to examine some of the failures of the present and to find out the reason for the lack of success of certain plastics. The wide scale substitution of ersatz materials for leather has not so far proved a success in Germany. This is in spite of the fact that such synthetic materials, e.g. vinyl resins, have all the obvious advantages of leather without its apparent disadvantages. They are, for instance, completely water resistant, chemically inert and possess reasonably satisfactory physical properties, such as elasticity, tensile and transverse strength and ability to withstand a certain amount of abrasion and flexing. Yet these properties are not sufficient to merit their use for shoe and boot uppers and soles if real foot comfort is to be considered. So far plastics have failed in this field because they are non-absorbent and almost completely impermeable. Leather, on the other hand, is freely permeable to air and is absorbent to the extent of taking up as much as 30 per cent. of its weight of perspiration and, later, permitting the same moisture to be rapidly evaporated. Air passes through leather by diffusion. A popular method of demonstrating this is by making a tight, gasket-like connection with a solid piece of heavy sole leather, and connecting through a system of tubing to a vacuum pump. Interposed between the leather and the pump is a trap containing water, so that the presence of air in the system may be detected by the passage of air bubbles through the water. Under a moderate vacuum it is not possible to exhaust the system so that air does not bubble through the water. Even when the degree of vacuum is increased sharply, the bubbles will start coming slower and slower and will finally cease. In a few seconds, however, especially if the vacuum is decreased slightly, the bubbles start again and are soon coming at almost their former rate.

Whilst it is not possible to manufacture a plastic material with the same architectural pattern as leather, it should not be beyond the realm of possibility to fabricate a form of plastic possessing means of ventilation. Already experiments have been made in Germany with an ersatz upper leather manufactured from specially extruded vinyl resin, the idea being to produce synthetically something akin to the natural structure of the hide. Naturally science has a long way to go before it succeeds in its strange quest, but the important fact is that research is proceeding along the right lines. Foot comfort depends primarily upon the ability of leather to allow the foot to breathe, that is, to excrete moisture in the form of perspiration, eliminate waste materials, exhale carbon dioxide and inhale fresh air.

Synthetic Resins for Water Softening

The shipping industry has recently become interested in the possibility of utilizing the well-known properties of certain phenolic resins made from quebracho, etc., for the production of "distilled" water for boiler work. At present the high proportion of salt in sea-water seems to indicate that such a process would not prove economic, although it would seem that a proper economic and engineering survey of the problem, that is comparative cost set against high cost of distillation plant and maintenance, has not yet been made. Until this is done we cannot agree that the whole process should be condemned out of hand. Admittedly, the resin beds are costly, but further research and larger production will no doubt lower the price.

Much of the original work on the subject was first developed in England at Teddington, and the technical development has since been fostered by United Water Softeners, Ltd. In the United States similar work has been going on for some years now, and it has recently been announced that phenol-formaldehyde resins can be prepared to function as cation exchanges.

School *for* Plastics

Some Notes on the first Technical Institute devoted solely to the teaching of plastics and plastics technique

Above, John Delmonte, Technical Director.
Right, E. F. Lougee, Chairman P.I.T.I. Advisory Board.

SOME months ago we gave the news of the formation of the Plastics Industries Technical Institute in Los Angeles, California, and the opening of its doors for the first time in October, 1940. To-day it has a large number of students who are working busily on their first course.

There is little doubt that this new Institute will have a profound effect on American industry, not perhaps on the production of new plastics, for research in this direction will continue to be carried out in the chemical research laboratories of the world, but on the production of specialized workers and executives for the plastics industry, trained in the plastics "tradition" and without a bias in favour of the older materials of construction. Indeed it is to be hoped that no bias will exist, but that a balanced view of all materials will be instilled. We strongly suspect that the Institute will also have a strong effect on plastics throughout the world.

It is, we believe, the first technical school in the world solely devoted to the study of plastics, which is in strong contrast to methods adopted in this country, where the study is incorporated in universities and schools as one branch of science among many. That both methods can provide good results is obvious, but it would appear that the Americans believe that segregation is necessary and that the ramifications of plastics are sufficiently wide and promising for such an institute to stand strongly on its own feet. We are rather inclined to agree with this view, especially since preconceived notions within universities and similar institutions may prejudice the growth of such studies through lack of enthusiasm and consequent lack of financial aid. A completely separate organism devoted solely to one end has much to commend it.

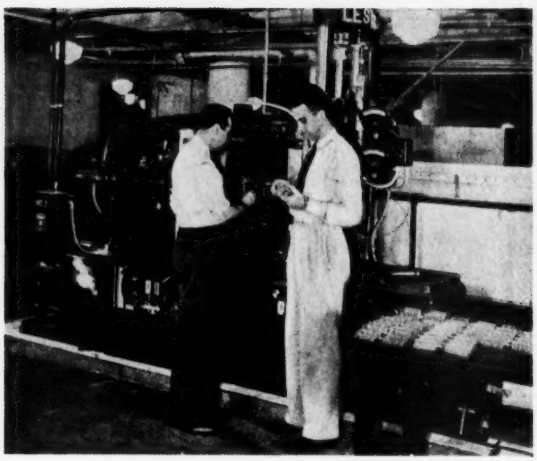
The Plastics Industries Technical Institute is housed in a beautiful modern building architecturally as new and as attractive as the industry it fosters. At least we can say that a beginning on sound principles has been made.

The accompanying photographs show some of the modern machinery that has been installed.

An injection moulding machine, laboratory compression presses, a completely automatic moulding press, tumbling barrels and finishing tools are available for converting moulding compounds into moulded parts. A laboratory for testing and research is being set up where students can observe the behaviour of various plastic materials and test their properties in actual use.

A complete line of fabricating machinery is in opera-

Students must first design their fabricating projects and then translate their blueprints into practical items from sheets, rods and tubes.



Usually working in pairs, students operate this injection moulding press at Plastics I.T.I. Later, their work is carefully inspected by instructors.

tion for the conversion of sheets, rods, tubes, and other pre-cast shapes, where students can work out their own projects and problems under expert guidance and supervision. They are taught, also, how to make rubber moulds and how to cast resins in them; how to form sheets; and what to do with extruded forms. Monomer casting is among the popular activities.

Each project begins in the drafting-room where students design the piece and write complete specifications for its production before any material is issued. The nature of the project, of course, is prescribed by the instructor. In this way, students with imagination and creative ability are given every opportunity to demonstrate their ingenuity. Some of the initial results are amazing indeed.

Equipment is essential, of course, but the personnel backing of any educational venture and its experience with, and knowledge of, the subjects taught is of greater importance to the student and his future.

Personnel at Plastics I.T.I.

John Delmonte is Technical Director. He was chosen to guide the training because of his practical experience in the plastics field. Mr. Delmonte was formerly with Chicago Flexible Shaft Co., as assistant chief engineer. Before that, he was materials test engineer at Naval Aircraft Factory, in Philadelphia, and research engineer with Firestone Tire and Rubber Company. He is a member of A.S.T.M., A.I.E.E., A.S.M.E., and a graduate of Massachusetts Institute of Technology.

Mr. Delmonte has placed Dr. John P. Trickey in charge of moulding and chemical research. Dr. Trickey, a graduate of New Hampshire University, pioneered in the development of furfural resins for Quaker Oats Co., and worked for six years with Carbide and Carbon Chemicals Corporation, of which Bakelite Corporation is now a unit.

Fabrication instruction is in the hands of C. K. Carstaing, who formerly operated his own plastics fabricating shops in Long Island. He was a winner of " Modern Plastics " Awards on four occasions and in 1940 was awarded a Certificate of Merit for distinguished work in plastics by the Philadelphia Art Alliance.

Intimate contacts with the plastics industry by the Institute are maintained through an Advisory Board consisting of Donald Dew, Diemolding Corporation; Dr. Gordon Kline, U.S. Bureau of Standards; Spencer E. Palmer, Tennessee Eastman Corporation; L. M. Rossi, Bakelite Corporation; and E. F. Lougee, former Editor of " Modern Plastics," Chairman.

Broadcasting Plastics

AT this stage of the life of the plastics industry it is of the greatest importance to promote a balanced and considered publicity of the materials and finished objects it manufactures. Broadcasts by eminent persons are especially helpful, and that by Messrs. Wornum and Barman, reported in full in the June issue of " Plastics," exemplified its usefulness. We hope that the number of these broadcasts will be steadily increased and actively fostered by the plastics industry itself. It would doubtless be a good step forward if some of the more knowledgeable of our technical men were allowed to broadcast and amplify on what has gone before.

A more recent broadcast, presumably to foster our export drive in the Mexican and South American markets, was that given by Carlos Aviles in the B.B.C. Overseas Service. Under the title of " The Plastic Arts," he gave a useful description in very general terms of what the plastics industry means and what it produces. " Plastics," he said, " cannot be used as substitutes for metal, wood, glass or porcelain in all those manufactured goods which are wholly or in part made of these materials, but only when they improve the quality of such goods; for example, lightness, fire-resistance, insulation, etc. That is to say, plastics are new products with qualities of their own, which can be put to greater use than any other known product."

The more we have of such publicity, the driving home of the facts of plastics, the insistence that plastics are used only where they improve the quality of goods, the more rapidly will plastics be accepted by the world. The speaker told also of the great inroads plastics are making in every industry, light and heavy, and of the future of our newer materials. We are greatly beholden to him, and only add that were it possible to continue the talk as a series, giving more specific data to industrialists, its value to the plastics industry would be enormously enhanced. We should not be surprised if, following the usual type of broadcast advertising campaigns carried out in the U.S.A. and fostered by large manufacturing concerns, plastics were not " put on the air " in a new form.

Applications of Polyvinyl Resins

The replacement of metal tubes by the new resins has aroused considerable interest as to the methods of joining

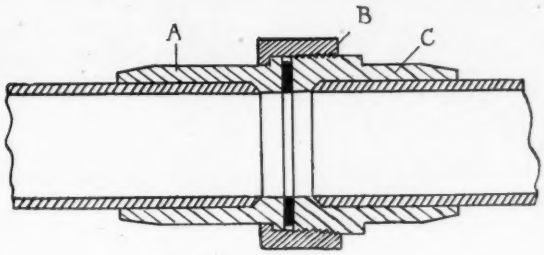


Fig. 1.—Jointing two polyvinyl-chloride tubes. A, plastic bushing glued on the tube; B, nut; C, collar with thread.

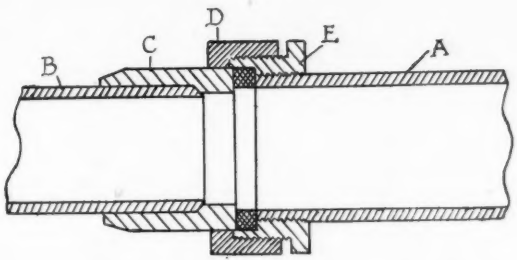


Fig. 2.—Jointing a polyvinyl-chloride and a metal tube. A, metal tube; B, plastic tube; C, plastic bushing; D, nut; E, reducing bushing.

By

W. Cornehli

KUNSTSTOFFE—in volumes 29 and 30, 1939/40—gives some interesting notes regarding polyvinyl-chloride products which are known now in Germany under the trade name "Vinidur." Under this name the materials known as Mipolam, Decelith, and Igelit PCU are apparently included.

Vinidur is non-inflammable, odourless, free of taste, physiologically unobjectionable and has the following properties:—

Specific gravity	1.38
Bending strength	13,500-16,000 lb. per sq. in.
Compressive strength ...	11,500 lb. per sq. in.
Tensile strength	8,250 lb. per sq. in.
Modulus of elasticity ...	4.8×10^5 lb. per. sq. in.
Hardness test	14,000 lb. per sq. in.
Impact strength	23-125 ft. lb. per. sq. in.
Softening point	176° F.
Resistance to heat:	
Martens	67° C.
Vicat	89° C.
Ohmic resistance M ...	3×10^6
Ohmic resistance after 96 hrs. in 80% humidity MΩ ...	3×10^6
Dielectric constant at 800 and 10° Hz	3.4

Resistant up to 104 degrees F. against water, salts, alkalis, solutions of ammonia, hydrocloric and sulphuric acid, 85 per cent. nitric acid, 55 per cent. formic acid, acetic acid, mineral oils, alcohol, but not resistant to aromatic hydrocarbons, ether, esters, ketones, and chlorhydrocarbons.

The material is sold in foils, sheets, boards, and tubes, from approximately .008-in. up to 1½-in. thickness, sheets and boards up to lengths of approximately 6 ft. Tubes are available in diameters of ⅛-in. to 6-in. in lengths of 10-13 ft.; tubes are also made capable of withstanding six atmospheres pressure. Furthermore, rods and hollow rods are available.

Machine operations consist of turning, drilling, milling, sawing, guillotining or bending, drawing, punching, stamping. The instructions given for the first part of these operations are similar to those for the machining of light metals, that is, high cutting speeds, small depths of cut with sharp cutting edges of the tools. In principle this also applies to drilling and milling operations. It has to be borne in mind that polyvinylchlorides, in common with other plastic materials, have a low thermal conductivity; it is therefore necessary that the heat generated on the spot of the machining operation be dispersed quickly. As lubrication is not possible, compressed air is used for cooling purposes. With regard to saws, those with set teeth work more efficiently. Sheets and boards up to .08-in. can be cut by guillotine.

To get good results it is important to follow the instructions given for machining operations such as bending, drawing, welding, etc. To bend tubes they are filled with sand and on both sides closed by well-fitting wooden stoppers. No air should remain inside the tubes. A warm current air, hot oil or a level temperature flame are used to heat the tubes slowly and evenly to make the material soft and plastic. In tubes over 3 ins. diameter the sand should be warmed up. The correct degree of plasticity is arrived at when the tube, held obliquely, begins to bend, that is, at a temperature of about 265 degrees F. The sand should fill the whole length of the tubes very tightly to avoid any folds. The actual bending is done on flat tables with the help of jigs, and until the tubes have cooled off they should be fixed in their position. The cooling process can be accelerated by using cold water. The radius of the curve should not be less than double the diameter of the tube. For shaping sheets or boards it is preferable to make use of moulding tools of steel, light metal or resin bonded wood, if the number of pieces to be produced justifies the provision of a tool, otherwise the shaping may be done by hand. Thin sheets can be punched by slowly impressing the cutting tools into the material previously warmed to 80 degrees F. Electrically heated (150 degrees F.) stamping tools are best used for stamping purposes.

Very interesting is the application of the autogenous welding process of metals for polyvinyl-chlorides. (See "Plastics," April, 1941, page 80). The welding process has many advantages compared with cementing, as it

is less complicated, avoids long drying times and adjoining parts can be connected without overlapping. Filler rods are of polyvinyl chloride, approximately ⅛-in. diameter. The welding is done by blowing air at 480 degrees F., which softens the filler rod and gives an insoluble joint to the parts.

If glueing is to be applied, it is important that the parts fit well on top of each other. The surfaces should be properly smoothed out by filing or working with emery cloth and rubbed down with methylene chloride to remove dirt and oil. A variety of glueing pastes made from polyvinyl chloride are available. The glue is spread on the sheets avoiding any air bubbles, the sheets are put together and held by some device until drying is complete.

As resistance against corrosive materials is very good, polyvinyl-chloride foils are mainly used for the coating of metal containers, but wooden containers, or even concrete and masonry generally, can be coated by foils. Here, too, it is important to clean and smooth out the surfaces, if possible, by sandblasting. Every coat must dry for at least 12 hours. After the foil has been spread over with the glueing paste and dried the foil will be stuck on the surface of the container, which has been previously heated up to a temperature of about 260 degrees F. For good results air bubbles are avoided and the foils should overlap each other by about 2 ins. The quality or lack of adhesion can be examined by measuring the electrical resistance.

For the joining of tubes two techniques have been developed either by insoluble sleeves or by connections with screws and flanges. Fig. 1 shows the join of two polyvinyl-chloride tubes, Fig. 2 that of a plastic and a metal tube.

The excellent chemical resistance of polyvinyl-chloride material make it valuable for replacing metal and rubber in the chemical industries, but the food industry also makes good use of it as pipe lines, filling funnels, cans, buckets, etc.

LITERATURE

E. Roemer, "Verarbeitung and Anwendung von Polyvinylchloride." (Manufacture and Application of Polyvinylchloride.)

A. Krause and K. Mienes, "Organische Spritztoffe." (Organic Injection Moulding Materials.)

H. Raalf, "Die Verarbeitung van Thermoplastischen Kunststoffen." (The Manufacture of Thermoplastic Materials.)

Plastics *and* Powder Metallurgy

By H. W. Greenwood

THE compression and curing of a plastic powder is perhaps the commonest operation in the plastics industry, and it might be thought that there was some analogy between that and the compressing and heat treating of powder metals. In fact there is practically none. When the plastic powder is compressed and heated a chemical change takes place, described generically as a condensation, and a new product is the result of an irreversible change or reaction. Within very wide limits the particle size or form of the plastic powder is of no great importance, nor does it exercise any notable influence on the properties of the resulting mass.

With metal powders the very opposite is the case, particle size and form are of first class importance and, other things being equal, will determine the nature and properties of the pressing made from them. In some cases particle form is of greater importance than particle size, and the extent to which these two factors, form and size, can influence results has to be experienced to be believed.

The powder metallurgist, cognizant of this importance, thinks of his powders in terms of form and size almost more than in terms of chemical composition. So far as chemical composition is concerned he deals with comparatively few elements, and for the most part the commoner metals. Particle form not only decides such things as packing factor and sometimes flow factor, but it may quite well be the deciding element in the economic success of a particular process.

Effect of Particle Size

Another factor of prime importance to the powder metallurgist is the influence of particle size on the speed and readiness with which metals oxidize. This should also be borne in mind by the plastics man, for it is quite possible that ease or otherwise of oxidation may influence the results he can obtain when using metal powders for a specific purpose.

As can be imagined, particle size has, as a rule, to be quite carefully considered in order to ensure that an advantage in one particular direction is not neutralized

by a disadvantage from another. For example, it may be found that one particular advantage is gained by reducing the size of the particle, or by specifying a smaller mesh. Then quite suddenly it is found that something has gone wrong and the results are much worse than before. It may well be that what has happened is that particle size has been reduced beyond a point where oxide film is negligible; with decreasing particle size, increased and accelerated oxidation takes place and so, in place of dealing with a clean metal particle, one is dealing with what is virtually a particle of oxide.

The possibility of this seriously interfering with the use of metal powders in plastics is remote, but it is worth remembering.

Effect of Metal on Flow

Then there is the question of flow factor, which, quite simply, is the ease, or otherwise, with which the powder flows. In routine operations where successive portions of powder have to be fed through a gate, hopper or other device, in measured quantities a condition applying more and more in these days of mass production, it is essential that the powder should flow readily. Two factors play a part here, particle shape or form, and particle size. As might be expected, powders with particles of spherical form have the best flow factor, other things being equal, also there is a size limit below which flow factor deteriorates rapidly or the powder ceases to flow at all. Here the finer the powder the poorer the flow factor. In general, powders passing 100 mesh but retained on 200 mesh have good flow factors if of spherical particle form. Powders of less than 200 mesh have, in general, poor flow factors, while below 300 mesh they may cease to have a flow factor at all. As might be expected, metals vary in the ease with which their particles flow or move, some are much more adhesive than others. Very generally the softer the metal the poorer its flow factor and vice versa; the density of the metal can also play a part.

There are many methods of producing metal powders, but those by which the great mass of powder on the market to-day is produced can be divided into three methods, the first providing a spherical particle which includes all so-called blowing methods which may be likened to the action of a perfume sprayer or atomizer in that in some practical manner a jet of air is brought to play on a mass or jet of molten metal. There are many modifications of this process, but practically all the spherical particled powders are produced by one or other modification of blowing. Next there are the flake powders which are so largely used for decorative purposes as metallic inks, for protective purposes as paints and the like. These are produced by percussion methods which may well be considered as lineal descendants of the old art of gold beating, with the difference that they produce thin flake instead of a leaf. The flakes are very small, in fact the majority of them average only about a micron in diameter (1 micron = .001 millimetre). The third method, which produces a particle having a dendritic or mossy form, is electrolytic deposition. This particle form is largely used in the fabrication of porous metals and, as can readily be imagined, lends itself to binding well under compression. It is the particle form not likely to be required by the plastic manufacturers as frequently as the other two groups.

In any case where the plastic manufacturer desires to use metal powder he will be wise to consider beforehand to what extent particle size and form can affect the result he desires to attain, also whether he is restricted to one particular metal or alloy or has a reasonable breadth of choice. This will depend upon his reason for using metal powder. Is it to modify the characteristics of his plastic, by endowing it with properties which, as a plastic alone, it does not possess, such as hardness, or conductivity either of heat or electricity, or is it to obtain a particular effect. In the last case, is it a surface effect alone or should it permeate the whole of the body of the plastic? Again, one may consider the use of metal in order to enhance the artistic or æsthetic appeal of the material or the article. Here the powder metallurgist can help by supplying a very wide range of coloured alloys which are capable of very effective use in ornamentation. It has to be remembered that these materials are very different in properties to the dyed flake powders used for sign writing, etc.

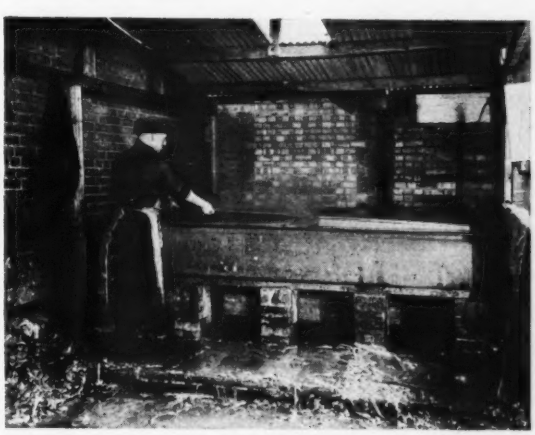
In whatever manner the powders are used and whatever their purpose it will always be an advantage if the user has clear ideas as to just what powder he wants, and what he wants it for.

Care in Choice of Raw Material

There is nothing mysterious in the properties of powder metals, and in a sense that is all that this article is intended to convey. It does explain the lines along which the powder metallurgist thinks of his materials and to a large extent why he does so. It will not be a difficult matter for any plastic technologist who desires to use metal powders to consider his own problem in terms such as the powder metallurgist himself uses. In this way he is much more likely to get material which will exactly suit his requirements, or he can at least discuss them with the powder metallurgist in reasonably equal terms. What is more, he may be guided to think carefully over the question as to whether powder metal can provide the solution to the problem he has set himself. In any case he will realize that a bare request for copper, tin or silver powder is as little likely to provide what he requires as the demand for a piece of paper is to produce a sheet of bank-note paper.

PLYWOOD WATER TANK

The hot-water tank seen in the photograph below is constructed of resin-bonded plywood. Built by Flexo Plywood Industries, Ltd., it is used as a treatment tank for conditioning plywood. It is water resistant and has stood up excellently under the stringent conditions.



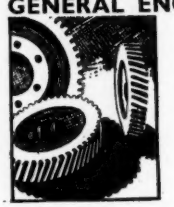
World's Industry

BUILDING

Panels and overlay for walls in Astralon are not entirely novel, but have proved so satisfactory in service and have received such a welcome from architects, that Rohm, in a recent issue of "Kunststoffe," saw fit to present an excellent summary of notable current achievements. Typical instances are illustrated of the use of the plastic in homes, offices, public rooms, toilet compartments and hotels. Stress is laid on the ease with which the semi-manufactured material may be fitted into place, the wide range of decorative possibilities its use opens up, and its pre-eminent value in the face of a wide range of factors promoting rapid deterioration of most other materials applicable to similar purposes. **Thermosetting resin extrusions** and their application, in particular to the building trades, were discussed by Tochtermann, of the Neoresit Strangpreszwerke, before a recent gathering of the V.D.Ch. Those interested in the present exploitation of extruded-metal sections will find significant likeness between these and many of the extrusions described by Tochtermann and expressly designed for decorative work in automobile coachwork and in the home. The author treated at length on essential features of design, not only in the precise form of the original sections, but also in the technique employed to form them up and build them up into satisfactory finished structures entailing minimum reworking and processing. **Plastic plumbing** is considered in certain of its aspects by Pallas, in a recent issue of "Wärme." The author observes that the relatively low strength and high sensitivity to heat of plastics, as compared with metals, has tended to hinder the development of the former as structural materials in this field. It is pointed out, however, that resins are now available in which these disadvantages are less marked than formerly and that additional strength may be obtained by armouring or reinforcing with metal. An interesting application is the use of plastic piping for low-temperature (−40 to −50 degrees C.) liquids. From the structural standpoint, plastic piping systems must be provided with adequate expansion joints at intervals of about 25 yds. A variety of methods exist for joining lengths of plastic piping; clamping rings, through-bolted washers engaging flanges on the respective tube ends, etc. Tee joints and special components are (in Germany) available in a number of resins, as is also resin-clad steel tubing for special purposes requiring very high rigidity. No special precautions are necessary when joining plastic tubing to metal tubing. **Wall decorative motif and map** are combined in the air line routes chart, designed by Richard Gaige and recently installed in the directors' room in the New York Air Line Terminus. Set on a copper map of the United States are thin strips of clear cellulose acetate, indicating principal routes, and red fluorescent cellulose acetate strips indicate the particular route concerned, whilst the cities are shown by Lucite inserts illuminated from behind. The map measures 3 ft. by 4 ft.

ELECTRICAL

Tramway-vehicle bearings in plastic were investigated a short time ago by Garbotz, of the Tech. Hochschule in Berlin, and reported in No. 11 "Mitteilungen des Forschungsinstituts für Maschinenwesen beim Bahnbetrieb." Running-wheel axles on trams are given generous allowance for play; hence, bearing surfaces are subjected to highly unfavourable condition of stress. Nevertheless, experiments showed that a cotton-filled resin with a 65 per cent. (cresol) base and an asbestos-filled resin with a 60 per cent. (cresol) base both gave satisfactory results, especially the latter. Both materials were cured slowly and both have remarkably high resin contents. **Bearings for electric motors and dynamos** have not proved so advantageous as in many other machines, according to Bluhm, writing in a past issue of "ETZ." The design of such equipment, and the fact that it frequently runs hotter than might be considered good practice for many other machines, is often due partly to the relative difficulty of obtaining adequate cooling and partly to electric effects. The result of isolating a shaft from its supporting housing by a plastic bearing at low thermal conductivity is to prevent sufficiently rapid heat dissipation, say, from an armature via the motor casing. **Electrical properties of textile fillers** for plastics were investigated recently by Weidmann and reported in a late issue of "Kunststoffe." The author points out that the value of resins so filled depends, for their satisfactory application in electro-technology, upon the physical and chemical properties of the textile particles under a wide range of conditions. Principally of interest is their electrical resistance. Curves were developed from which it was seen that the resistivity of such fillers decreases with increasing temperature, the effect being comparatively small in the case of viscose, cuprammonium-chloride cellulose and cotton, pronounced in the case of acetate "silk" and more evident still in the case of natural silk.



GENERAL ENGINEERING

The German State Railways have vigorously exploited the possible uses of synthetics for some years. **Brake linings,** for instance, have been entirely made of synthetic rubber, and packing washers of the same material for axle boxes seem promising. Synthetic resins have also been successfully developed both for floor-covering and roofing purposes in railway coaches; mipolam is especially referred to. Artificial leathers are widely used for upholstery. Metzkow, in a past issue of "Glasers Annalen," notes in his account on these matters that the change-over from traditional materials to synthetics did not necessitate radical changes in machining or fabricating equipment, whilst time was saved owing to the abolition of many surface-finishing operations. **Bearings of plastics for reciprocating machine parts** are considered by H. Ragotzi in a report published recently in "Maschinenban/der Betrieb." A laminated plastic, Calypsol, was eventually found suitable for one particular machine at Krupps and was proved equal to bronze, even for heavy loading on a short stroke. The plastic was employed in the form of strips 1 metre long, 10 mm. deep, set in accurately milled slots in the guides. Adequate lubrication was found essential for satisfactory working. **Polishing plastic components by tumbling** was discussed by Mount in a past issue of the "Machinist." Amongst the materials recommended as polishing media is hardwood sawdust, free from tar or rosin; this may be used alone or as a diluent for a more active abrasive. Final polishing may be carried out by tumbling for an hour with a non-cutting medium. The tumbling method

...mploys Plastics

is better than straightforward polishing on wheels, as the work, being a poor conductor of heat, is liable to warm up unduly and to discolour (or soften and "drag"). **Aluminium and metal parts** on the Evinrude outboard motor have been replaced by plastics moulded in Bakelite by Eclipse Moulded Products Corporation and others. The parts concerned are claimed not only to show greater resistance to moisture, greater durability and greater economy than the metal parts they replace, but, in addition, to enable improved designs to be used.

CHEMICAL

Equipment in industrial laboratories in particular must, as a rule, combine notable robustness with reasonably low cost. Wirth, in a past issue of "Kunststoffe," describes an interesting application of asbestos sheet in the form of a compound mass consisting of two layers of asbestos, one on each side of an intermediate layer of hard paper, the whole being bonded together by a thermosetting plastic. The material is employed, inter alia, for laboratory table tops. It is said to have a compression strength of 10 tons/sq. in. and to resist penetration, scratching and "tearing" twice as well as hard rubber. Its heat resistance is naturally high, whilst its mechanical strength is such that bench vices may be bolted down direct on to its surface with no danger of splitting. **Resistance of "hard paper"** on a urea or phenolic-resin basis to a variety of corrosive chemicals was investigated some 18 months ago by Werne Paul and reported in "Kunststoffe." The author of the work presented a detailed tabular analysis of his findings, together with a condensed summary. Hardened urea-resin-treated paper was shown to be strongly attacked and destroyed by concentrated alkalis and inorganic acids. Hardened phenolic-resin-treated papers were also destroyed by these reagents. Hydrogen peroxide destroyed the amino resin, laying bare the paper base, but had no effect on the phenolic material, which reacted merely by absorbing the customary amount of water. Mono- and polybasic alcohols, simple or substituted hydrocarbons, organic acids and oils affected neither group of materials. Ether, acetone and methylene chloride showed no effect on the amino resin, but on at least one grade of phenolic-resin-treated paper caused slight blistering. These results are, in our opinion, of considerable interest to those branches of engineering calling in some measure for consideration of conditions resembling those encountered in chemical engineering (e.g., electro-deposition).

TEXTILES

Textile machinery, because of the high speed at which it frequently operates, was early recognized as a fertile field for exploitation of the low density and high strength of plastics. Beha, in a recent issue of "Kunststoffe," analyses some current applications and studies the use of synthetic resins in this sphere. Amongst the examples cited is a yarn spool consisting of a phenolic-resin boss with spring-steel arms, suitable for artificial silk, fine cottons and wool. Because of the overall smooth finish which may be given to the resin, and because no screws, bolts or rivets need be used in assembling, this spool design is both economical and technically advantageous. Moreover, the nature of the resin is such that it fouls neither the yarn nor the hands of operatives. The spool is available in circumferences of 40 to 45 ins. Slit drums, formerly made of nickel-plated cast iron or fabricated around a central shaft from metal sheet, were displaced by others in phenolic resin some years ago. The non-metallic drums are not only lighter in weight, hence smoother running and safer at high-speed operation, but definitely economical in that less wear and tear is imposed on machine bearings and less power consumed in operation. As opposed to the necessarily bright, highly reflective, silver-coloured finish of the older metal drums, the plastic drums are in a matt-brown finish and the yarn is easily examined and followed without undue fatigue. Again, as opposed to metal, harmful condensation of moisture does not so readily occur on the plastic surface, of which even the inner surface is finished dead smooth to avoid the adhesion of dust. Other plastic parts are stepped spools, which resist the heavy wearing stresses imposed by the yarns and which retain a smooth, splinter-free surface for long periods of operation. Such spools are made with diameters at the foot end ranging from about 3 ins. to 6 ins. Braking rolls for thread, formerly made in brass, became quickly grooved by the abrasive action of the yarn and had frequently to be replaced; this disadvantage has been obviated by the considered choice of suitable plastics in place of brass.

MISCELLANEOUS

Physics and mechanics of fillers for resins have still not been entirely elucidated and practice is still based largely on empirical reasoning. Among research contributing to present knowledge is that sponsored by Garco Products Inc. (Ford City, Penna.). It has been shown that "Gartex," a so-called processed silica, gives, when employed as a filler, both improved working properties in moulding powders and enhanced quality in the finished product. **Selection of specific resins for specific jobs** is dealt with by Huffschmid in a past number of the "Berliner Tageblatt." The author points out that in 1937 one-third of the total plastic products on the world market came from Germany. He enjoins careful attention to design when transferring from another structural material to plastics, warns against hasty, uneconomic substitution and stresses the need for building up a sound repute for export purposes. **Ornaments and fixtures for articles of clothing** are dealt with systematically by Kunzel in a recent issue of "Kunststoffe." The author considers the technology of manufacture and processing for buttons and analogous items in casein, acetyl cellulose, phenolic and urea resins, and in thermoplastics. He emphasizes the importance of the latter materials, due to the ease and speed with which they may be worked up. **Shipbuilding** calls for special properties in the materials of construction employed, not only for the main structures, but also for interior and decorative work. The noted resistance of cast Dekorit to the action of water and of corrosive aqueous solutions has led to the suggestion being put forward that it be used for marine fittings, particularly toilet and bathroom fittings. Apart from this relatively minor application, those same qualities of permanence have long commended it for electrical use under similar conditions on board ship.

Inquiries and Answers

(In Which is Included General Correspondence)

IMPORTANT NOTICE: If inquirers wish to receive replies by post, a stamped and addressed envelope must be included in their letter. It is understood that the submission of a problem to the Editor permits its publication in this journal.

Moulded Boxes

We are desirous of being put in touch with a capable manufacturer of boxes which would contain certain of our products, such as draughts, chess, etc., and we think that Bakelite would be very suitable.

We understand that you pass this information through your columns to manufacturers and should be grateful if you would mention our requirements.

JAS. LILLYWHITE FROWD AND CO.
London, S.E.1. (Frowds, Ltd., Proprietors.)

[EDITOR'S NOTE.—Boxes for the purpose have already been moulded from synthetic resin. Unless the job is for export or for teaching our generals military strategy and tactics which are so similar to chess problems, we fear that moulding powders may not be readily available. Will those moulders interested please write direct to the inquirers?]

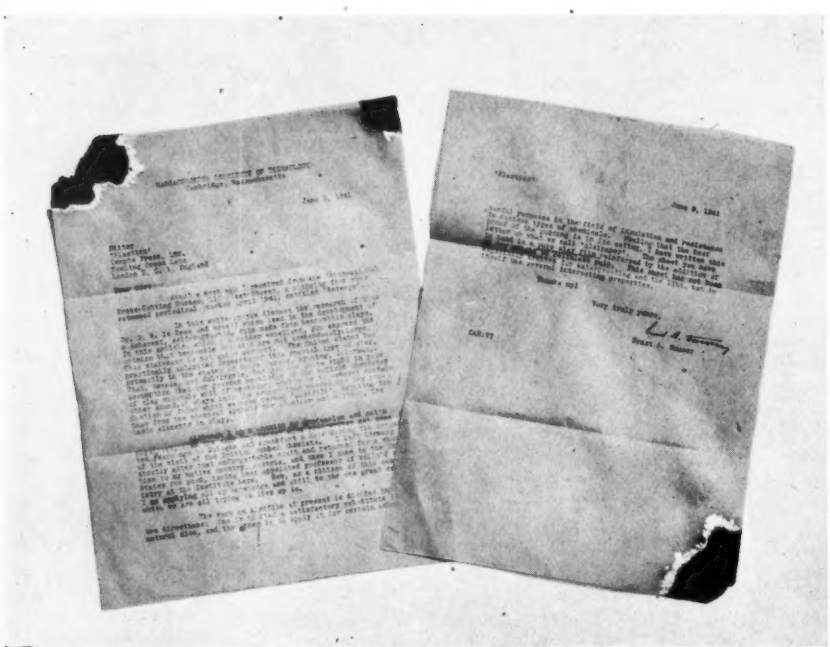
Coherent Clay Films

About a week ago I received from the International Press-cutting Bureau, 110, Fleet Street, a clipping from your esteemed periodical marked April, 1941, entitled "Revenge."

In this write-up you discuss the research of Miss le Beau and myself which led to the development of a coherent, self-supporting film made from bentonitic clays. In this article, which I consider excellent, you express the opinion that bentonite deposits are not tremendously large. This statement is not quite correct. The United States has practically unlimited deposits of this special type of clay, primarily in the States of South Dakota, Wyoming, Colorado, Utah, Nevada and California, but you are quite right in your assumption that our present knowledge of the colloid chemistry of clay minerals will, if necessary, enable us to convert certain other abundant clays into the proper type needed for the production of films which we have termed "Alsifilm," deriving the name from the chemical symbols for aluminium and silicon, the basic elements in clays.

Although I am a chemist by profession and not a physicist, I am the same Dr. Hauser whom your writer met some 10 years ago in Cologne and Frankfort-a-Main during the occasion of the visit of the British rubber chemists. I left Germany shortly after that unforgettable visit and returned for a short time to my native country, Austria, and then I came to the United States for good, having been appointed professor of colloid chemistry at the Institute here. Now, as a citizen of this country, I am applying all my knowledge and skill to the one great cause which we are all trying to live up to.

The work on Alsifilm at present is divided into two directions: One is to find a satisfactory substitute for natural mica and the other is to apply it for certain other useful purposes in the field of insulation and resistance to various types of chemical. Feeling that the best proof of the pudding is in its eating, I have written this letter on what we call "Alsipaper." The sheet you



The letter we have received from Dr. Hauser. The paper is made from bentonite clay and although it has blackened in the flame, it is quite non-inflammable.

have in hand is a pure clay film reinforced by the addition of 5 per cent. dry weight of cellulose pulp. This sheet has not been especially treated for waterproofing and the like, but in itself has several interesting properties.

Thumbs up!—Very truly yours,

ERNST A. HAUSER.

Massachusetts Institute of Technology,
Cambridge, Mass.

[EDITOR'S NOTE.—Readers will know of our general opinion of the letter and the paper on which it is written from our Editorial on p. 129. This is a rather staggering discovery, and we wish Dr. Hauser the reward he merits from its development. We also feel that the fundamental research work he has done on bentonite will also develop our knowledge of plastics from the physical and physico-chemical point of view. We should very much like to know what a laminated form made from resin-impregnated bentonite film looks like. Its electrical properties would be interesting.]

Replacement of Steel Tubing

I should be glad to know whether one of our plastics manufacturers is in a position to supply for export to Eire a tubing of plastic material to take the place of steel tubing for electric wiring. Steel tubing is usually in 12½ ft. lengths, and the sizes mostly in demand are ¾ in. and 1 in. internal diameter with outside diameters of 0.894 in. and 1.144 ins.

E. C. HANDCOCK, M.I.E.E.

17, Fleet Street, Dublin.

[EDITOR'S NOTE.—It would seem that extruded tubes of the phenolic type are required. These can be supplied in any length, and any internal and external dimensions, although, so far as our information goes, the application has never yet been made. With care, the tubes can be threaded, but for right-angle joints metal would be employed. Inquiries should be made to F. A. Hughes and Co., Ltd.]

Rubber-like Seal

We would welcome any information you are able to give concerning the composition of the sample enclosed with this letter. This particular sample has been used as a seal and originally came from the United States of America. We know of no similar product in this country, and should you be in a position to let us have the name of any supplier of a product similar to the sample it would be appreciated.

Hinckley. BURGESS PRODUCTS, CO., LTD.

[EDITOR'S NOTE.—The sample sent is a transparent rubbery material that seems undoubtedly to be a polyvinyl compound. Manufacturers of polyvinyl chloride in Great Britain are I.C.I. (Plastics), Ltd., Welwyn, and BX Plastics, Ltd. Polythene strip, which is also made by I.C.I. (Plastics), Ltd., would serve admirably for the same purpose.]

Wax Slicing Machines

We should be obliged if you could give us names of manufacturers of slicing machines suitable for cutting wax sheets for dental work. We are at present using an ordinary Berkel machine.

London, W. H.A. and Co.

[EDITOR'S NOTE.—We presume that celluloid slicing machines would do the same work for wax. The inquirer should write to the following concerns:—Henry Berry and Co., Ltd., Bertrams, Ltd., David Bridge and Co., T. H. and J. Daniels and Co., Francis Shaw and Co.]

Langanivite Jointing Paste

Can you tell us the manufacturers or sales agents for Langanivite jointing paste? B.A.

[EDITOR'S NOTE.—The name is not an error for Langite, the well-known product of the Cork Manufacturing Co. It is new to us.]

The Invisible Aeroplane

I have read with great interest the article appearing in the June issue of "Plastics" entitled "The Invisible Aeroplane," and am particularly interested to see the photograph of an illustration on the cover of the "Illustrated London News" of January 15, 1916. As a matter of fact, an original cover is amongst the papers at these works.

I was also interested to note that Dr. Eichengrün in his article does not refer to anything earlier than 1917, although transparent sheets were used in aircraft construction considerably before that date.

At the Military Trials in 1912 on Salisbury Plain an all-enclosed Avro monoplane was flown by the late Lieut. W. Parke, R.N., and cellulose acetate sheeting was used for the windows.

In the following year at the International Aeroplane Exhibition, in Paris, a biplane was exhibited, constructed, to the best of my knowledge, by Messrs. Coudron Frères, in which the wings and fuselage were entirely covered with acetate sheeting, and no fabric was employed. I am not certain whether, or not, this aeroplane ever flew, but there was a notice on the stand stating that the transparent sheeting had been manufactured by the Société Industrielle du Celluloid, the material in question being named Sicoid. At that time I understand this Société held the rights from Rheinisch-Westfalische Sprengstoff A.G. to manufacture this material in France under their patents.

Prior to the outbreak of war in 1914 Cellon, Ltd., was importing transparent sheeting, both from France and Germany, and supplying the sheets to the aircraft industry in this country.

A. J. A. WALLACE BARR
Surrey. (Cellon, Ltd.).

Plastic Printing Type

In your June issue, on p. 118 (second column), under the head "General Engineering" you make reference to an article in "Kunststoffe" on type-making in plastics. For obvious reasons I am interested in this phase of plastics and would be extremely grateful if you could tell me (a) how to obtain a copy of the publication mentioned: and (b) whether it is available in translation.

Welwyn. BROADWATER PRESS, LTD.

[EDITOR'S NOTE.—Owing to an oversight this note in the "World's Industry Employs Plastics" section of the June issue was a short repetition of what was already published at considerable length in our December, 1940, issue, p. 281. The latter is a complete translation of an article by M. E. Laeis (of Eckert and Ziegler) of the developments carried out in Germany by the Deutsche Verlag (the well-known publishing company), the Dynamit A.G. (the producers of the plastic material) and Eckert and Ziegler (the manufacturers of injection moulding machinery). Apparently the printing type, probably made from polystyrene, was completely successful.]

PRODUCTION NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes

WOMEN IN INDUSTRY.—The Ministry of Labour has just issued an Engineering Bulletin in which is described the extent to which women have been introduced into the heavy industries and the extraordinary efficiency they rapidly acquire. Three-quarters of a million recruits to the factory front are needed, within the next few months, for our war effort. The Services' claim upon men is not likely to slacken; what part can women recruits play in the drive for victory?

Because our need to employ women is inescapable, it is sometimes assumed that they are a desperate last resort—mere substitute labour, of dubious worth. That is the out-of-date view. It is true that there are certain difficulties in putting them on work normally allotted to men. But where the snags have been foreseen and properly allowed for some remarkable results have been achieved.

General labouring is not a promising sphere on the face of it. But throughout Scotland, and especially on the Clyde, large numbers of women are successfully employed on it.

In the Birmingham area, some seventy women are now employed at one works to cover aero-fuel tanks with layers of rubber. Putting women on this job was an experiment, as this was one of the tasks for which men had been considered essential. It has now been proved, however, that women recruits can reach a high standard of efficiency in only 10 weeks or so from enlistment.

That the heavy work of shell steel billet breaking is not outside a woman's capacity was proved in the Port Talbot Steelworks in the last war. Hundreds of girls were employed there, on three shifts, their work including band sawing, turning, and the operation of all the overhead gantry cranes, except the special-duty hot-metal cranes and charging cranes.

Assembling light railway wagons is another operation in which women have succeeded. At one I.C.I. factory they have taken on heavy deep drawing through presses. And tank assembly—normally regarded as essentially a man's job—has proved to be quite within the scope of selected women.

The tale seems unending. Women are stoking boilers, they are engaged in tapping, on capstan and turret lathes, welding, riveting, sheet-metal working, wiring, press-operating, toolmaking and so on. At one works in Halifax, and only after a couple of weeks' training, they operate lathes, gear planers, internal and external grinders, millers, drills, tooth rounders and keyseaters. Women did enough in the last war; they are doing even more in this.

MR. M. MOHR, one of the original directors of the Micanite and Insulators Co., Ltd., who died on May 27, 1941, in his 85th year, was a pioneer of the electrical insulation industry. He was associated with a small band of energetic workers who displayed wisdom and foresight in building up what is to-day the largest organization in the British Empire manufacturing electrical insulators and insulating materials.

Micanite was first manufactured in America in 1893 by the Mica Insulator Co., of New York and Schenectady, and in the year 1894 Mr. Arthur Berkeley and his brother, the late Mr. Edward Berkeley, undertook the introduction and distribution of Micanite products in Europe. They were joined in this venture by Mr. Mohr. Soon after it was decided to manufacture Micanite in England, and a small works was taken for this purpose at Stoke Newington, London. The premises soon proved inadequate for the expanding business, with the result that the works were removed to a larger site at Stansted, Essex.

The late Mr. M. Mohr.

As early as 1895 Micanite as a high-voltage insulator was brought into prominence by its use on the 1,000-kw. Ferranti alternator at the Deptford station, solving what, at that time, was a difficult high-tension problem.

In 1901 an English company was formed, entitled the Mica Insulator Co., Ltd., and another removal was effected in 1902 to more commodious premises at Walthamstow, adjacent to the present works. In 1906 the company changed its name to its present title, the Micanite and Insulators Co., Ltd., and in 1908 a larger factory was built at Walthamstow on the site of the present main works.

The production of Micanite continued on an ever-increasing scale, and just before the first world war the manufacture of bonded-paper tubes and boards was undertaken. Apart from its historical interest to the plastics industry, this event proved to be a far-reaching development of national importance which the initiators were at the time naturally unable fully to appreciate. To-day, such materials have widespread electrical applications as well as many purely mechanical applications, particularly in the aircraft industry, as substitutes for light alloys.

Numerous additions to the Walthamstow works have been effected from time to time, and other premises have been acquired, and to-day the company, the foundations of which were so well and truly laid by Mr. Mohr and his colleagues, employs over 1,500 people and manufactures all classes of high-voltage bushings and insulators for indoor and outdoor service, synthetic-resin bonded-boards of every description, Micanite in every form required by the electrical industry, varnished cloth, silks and tapes, and has one factory devoted exclusively to the mica industry.

Mr. Mohr was a man of vigorous and genial personality, who never spared himself, and was a continual incentive to effort to those around him. He had an abundance of human kindness which made him easy of approach, and, amid his business activities, always found time to take a personal interest in the employees. He will be greatly missed by all the workers in the company. To Major Mohr, the present managing director, we offer our sincere sympathy in his great loss.

HERBERT R. SIMONDS, of 20, Christopher Street, New York, informs us that he has joined the Plastics Shapes Division of Julius Blum and Co., 532, West 22nd Street, New York City, as technical consultant. The company has gone into the development of an open stock of all types of plastic material in shapes and long lengths.

M AND B PLASTICS, LTD.—Mr. G. C. Bell draws our attention to the fact that we described the concern of which he is managing director as May and Baker, Ltd. The name of the company is M and B Plastics, Ltd., and the offices have been removed to High Wycombe, Bucks. The offices of the parent company, May and Baker, Ltd., are, as previously, in Dagenham.

MR. J. McEWAN KING has resigned his position as managing director of Aeroplastics, Ltd., and will form a new company known as King Aircraft Corporation. Plastics manufacture will be one of the main activities of the new company and we understand that aircraft pilot seats moulded from resin-impregnated fabrics is to be one of its most important productions.

MESSRS. LAVINO (LONDON), LTD., the well-known manufacturers of high-efficiency mixing machines for the plastic industry, inform us that they have removed their offices from 29, Mincing Lane, E.C.3, to 103, Kingsway, W.C.2, to which address all communications should be sent.

FINANCIAL NOTES

Cascelloid (Leicester) has increased its nominal capital £100,000 in £1 ordinary to £175,000.

A return of allotments made up to May 1, 1941, shows 100,000 ordinary shares allotted for cash to British Xylonite Co. at a premium of 10s. per share.

Distillers Co.—In spite of the reduced earnings and lower dividends already announced by some of the whisky distilling subsidiaries of the company, the market had been expecting a maintenance of the final distribution by the Distillers Co. for the year ended May 15. This expectation is now fulfilled; the final dividend of 8¾ per cent. is again accompanied by a bonus of 1¼ per cent., making the year's payment at 16¼ per cent.

Net earnings, after provision for taxation and contingencies, are lower by £288,531 at £2,110,936, but the surplus over the dividend requirement appears from the preliminary figures to be on the same scale as last year. Heavier taxation would appear to account for the fall in earnings, so that any reflection in the profit and loss account of the restrictions on distilling and smaller sales of spirit in the home market (last July the chairman said the increases in the duty had to that date caused a marked decrease in these sales) has been offset by improved results in other directions. The group's export trade is extensive, while it possesses a remarkably wide range of interests—its manufactures include chemicals, yeast, plastics and industrial alcohol.

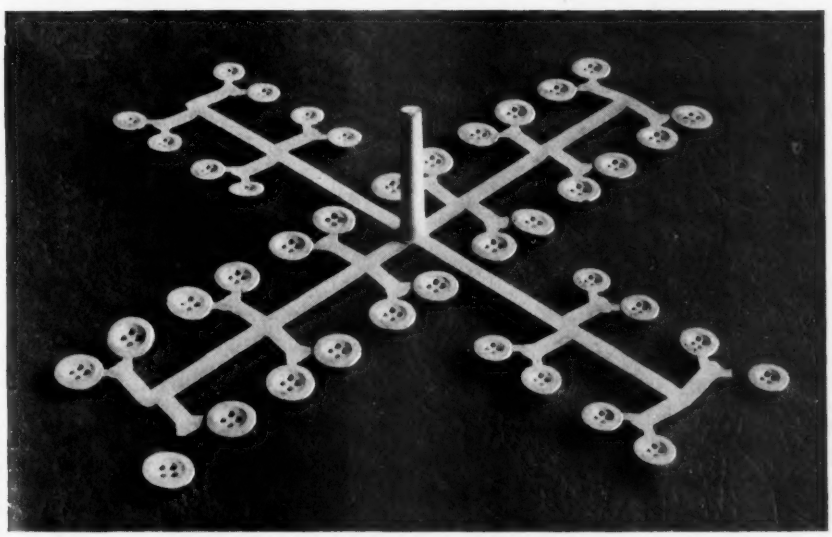
Lacrinoid Products. — The wide demands of the products of this company are reflected in the news that the trading profit has doubled in comparison with that of last year. Mr. Leopold Lazarus, the chairman, explained to shareholders at the meeting on Thursday that the result was achieved in the face of unusual difficulties and after providing for depreciation on a larger scale than before.

Total sales increased by about 20 per cent. and work in progress has remained at a steady level. The whole of the plant is now working to capacity.

Combined Optical Industries, Ltd.

Since our description of the work of this concern three years ago, progress has been steadily made, although without any fanfare of trumpets. Our readers will remember that optical "glass" moulded from methyl methacrylate is the main object of the company and that remarkably optically accurate specimens of lenses thus made were on show at the last British Industries Fair. They were in themselves wonderful achievements of the plastic moulding art and of the science of mould making, and while the examples shown were stressed as being lenses for cameras, simple magnifying glasses, etc., yet we all knew that the final goal of the company was the production of spectacle lenses. What such manufacture means can be well imagined—surface hardening of the methyl methacrylate resin to remove the disadvantage of scratch formation by constant cleaning and, perhaps more important, the production of a very large number of costly accurate moulds to cover the diverse and numerous needs of the public. Great progress towards this end has, indeed, been made, and we look forward with excitement to the time when the full announcement of success will be made. May this be very soon!

In the meantime, magnifying lenses have been produced for a variety of purposes for the Army, Navy and Air Force. Moreover, the company has proceeded rapidly with the injection moulding of polystyrene and cellulose acetate. The accompanying photograph shows an excellent example of the work carried out.



The moulding of buttons for the Navy is being carried out by Combined Optical Industries. The photograph shows the production of 40 buttons at a shot.

SCREW THREADS IN PLASTICS

In the Preceding Section of this Account Attention was Devoted to the Production of Threads by Various Means in the Plastic Mass itself

The Following Discussion deals with the Practice and Advantages of Employing Threaded Metallic Inserts to Replace Threads Direct in the Plastic

IT should be understood in the following discussion upon the use of moulded-in inserts that the observations made are valid not only for threaded inserts, but also for non-threaded inserts, whether in metal or in a non-metallic substance. They may even consist of separate components formed in plastic by a casting moulding or injection moulding process. Metallic inserts are employed to give higher strength of thread and to reduce the threaded length which is necessary for both moulded and cut screws. A special operation or series of operations, however, is necessary in order that the metallic part may be inserted and correctly located in the bulk of the plastic.

Designs which make an unscrewing operation necessary, in practice, are generally not considered suitable; the finished part should be capable of removal from the mould without further operation. Furthermore, there should be present no flash or overflowing mass to remove from the top or bottom of metal inserts in order to make them ready for use.

Disadvantages of Inserts

Bearing all these factors in mind, it is obvious that the correct procedure for the use of metal inserts in plastics can assume a somewhat complex form. Usually metal inserts are considered more expensive than moulded or cut threads, but this can only be decided by specific calculation of costs involved in the separate processes. The use of metallic or non-metallic inserts in moulded plastics involves consideration of the following points:

(1) Dislocation or deformation of the inserts and the insert holding pins, owing to the high moulding pressure.

(2) Penetration by the plastic mass of holes and cavities in the insert.

(3) Possible difficulties in removing the finished part from the mould owing to shape of insert.

With regard to the first point, very thin holding pins (those, for example, up to 3 mm. in diameter and of greater length) are liable to become bent; hence, location of the insert is liable to be interfered with, whilst subsequent removal is made difficult. To overcome this, it is recommended that the holding pin be provided with a strong tapered base, as in Figs. 21 and 22.

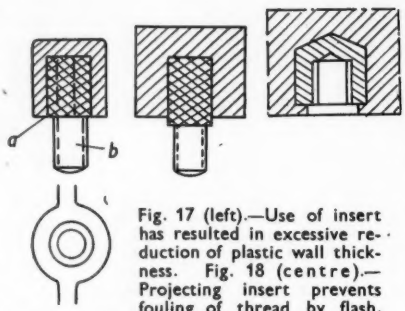


Fig. 17 (left).—Use of insert has resulted in excessive reduction of plastic wall thickness. Fig. 18 (centre).—Projecting insert prevents fouling of thread by flash. Fig. 19 (right).—Plastic projects beyond the insert, hence fouling of thread is obviated.

Prevention of cavities becoming inadvertently filled with plastic will depend upon the design in hand. However, whatever steps are adopted, they should cause the minimum of interference with the flow of the plastic bulk, as ideal flow will, in general, result in the maximum clamping effect upon the insert, and hence provide it with maximum resistance to tensile and torque stresses, owing to the shrinkage of the plastic around it.

Table 3.—Allowances for Moulded-in Holes.

Nominal diam., in.	Normal series, in.	In special cases, in.
0.04 - $\frac{1}{8}$	± 0.0012	± 0.0008
$\frac{1}{8}$ - $\frac{1}{4}$	± 0.0015	± 0.00095
$\frac{1}{4}$ - $\frac{1}{2}$	± 0.0018	± 0.0011
$\frac{1}{2}$ - $\frac{3}{4}$	± 0.0022	± 0.0012
$\frac{3}{4}$ - 1 $\frac{1}{16}$	± 0.0026	± 0.0017
1 $\frac{1}{16}$ - 2	± 0.0032	± 0.0020
2 - 2 $\frac{1}{16}$	± 0.0038	± 0.0024
3 $\frac{1}{16}$ - 4 $\frac{1}{4}$	± 0.0043	± 0.0028

Wall thickness at the sides and bottom of metallic inserts should not be reduced too greatly (Fig. 17). If this be done, the body of the component is obviously weakened and is liable to crack or shatter. The insert should project by a slight amount (Fig. 18), as usually a flash covers the face (a) and fills the threads (b), making a burring operation necessary.

Another solution of the difficulty is that involving the projection of the plastic material, as shown in Fig. 19. Metallic inserts are usually of knurled cylindrical form, or of a hexagonal shape; the latter may be preferable. Because such metals are not corroded in contact with the hot plastic mass (phenol and amino), metallic inserts may be made of steel, brass or light alloys. It can be assumed that the strength of threads in steel and brass is double that of moulded or cut threads. A smaller height of female thread may therefore be used.

In the case of cap cuts (Fig. 23), however, this advantage is lost owing to the closed end and to the thickness of plastic over it. The broken curves in Figs. 1 and 2 refer to this and show clearly that in this case the difference in strengths between threads in plastics and in metal inserts is not always so great as could be expected.

Embedding Hexagon Nuts

Several methods may be adopted for the embodying of hexagon nuts. In Fig. 20 the nut is placed on a threaded pin so that, besides the metallic threads provided by the nut, threads are also formed directly in the plastic moulded round it. The nut is located first by screwing on the pin, and, after the moulding process has been completed, the pin is unscrewed from the

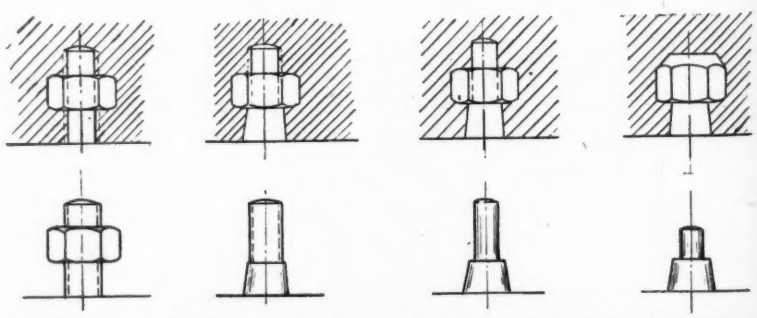


Fig. 20 (extreme left).—Location of hexagon nut by means of threaded pin; this entails a subsequent unscrewing operation and the pin is weakened by the thread. Fig. 21.—Locating nut by means of threaded pin which is mechanically strengthened by provision of tapered base. Fig. 22.—Location of nut by means of non-threaded pin corresponding to core diameter of thread in nut; pin has tapered base. Fig. 23 (extreme right).—Location of cap nut by non-threaded pin, again strengthened by tapered base.

finished part. Time is lost in this last operation, and the design itself obviously possesses serious shortcomings, for the maintenance of the location of the nut depends appreciably upon the skill and care of the operative, and upon the somewhat unpredictable flow of the plastic around the insert. Moreover, owing to the fact that it is completely threaded along its whole length, the pin itself is mechanically weakened. The only good that can be attributed to this design is that no plastic material can enter the thread.

In Fig. 21 the pin is strengthened by the tapered section at the root and a fixed position for the nut is provided. Again, however, both nut and dowell must first be screwed on and then unscrewed. By using the system illustrated in Fig. 22 this last operation is avoided. The pin used is again provided with a tapered root, but its upper diameter corresponds to the core diameter of the nut, which is located merely by slipping on the pin; the finished component being removed by a straightforward withdrawal process, i.e., the unscrewing operations are avoided.

The possible disadvantage of this design is the fact that the female thread cannot be carried beyond a height corresponding to that of the nut, and, moreover, on both the entrance and exit sides of the metal insert a small flash will tend to form, this necessitating a subsequent removal.

If a closed nut be used, as in Fig. 23, no such flash can be formed. As in the previous instance, the nut is merely placed on a pin corresponding to its core diameter, the root of the pin being again strengthened by a taper.

In certain special instances it may prove possible and advantageous to slip metal inserts into the finished job after moulding, simple moulded cavities being provided. Such a procedure, however, must obviously not involve the use of expensive or awkward movable parts in the mould.

Cut and Machine Threads

If it be found advisable, for one or another reason, to form threads in the finished moulded component, again, both advantages and disadvantages may be cited, whilst several methods exist for carrying out the necessary operation.

Obvious advantages for the production of threads by cutting are, that such threads may be located in precisely the required position, there is no danger of unforeseen dislocation, and no intricate allowances are required regarding moulding tolerances or wear of mould parts. The thread itself may be machined to any desired tolerances which are not limited by possible wear of mould parts or by shrinkage of the plastic mass.

On the other hand, disadvantages comprise the additional operation required in locating the component in a chuck (or in jigs or fixtures if higher accuracy be required), any of these methods entailing the risk of deformation owing to the clamping pressure.

Depending in some measure (although not entirely) on the filler used, plastics cause considerable wear on the cutting edges of ordinary high-speed tools; hence, for straightforward cutting operations the use of sintered-carbide or diamond-tipped tools is frequently recommended. Unfortunately, these materials cannot, as a rule, be commonly used for tools such as taps or multiple-point chasers. In the case of ordinary steel taps, thread tolerances are difficult to maintain; in fact, the high rate of wear of these tools is by

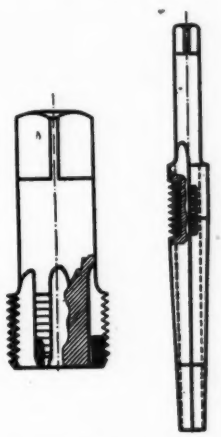


Fig. 24.—Taps provided on part of their cutting edges with hard-metal tips. In this way, high wear resistance is obtained without mechanically weakening the tap.

no means as commonly recognized as it should be.

If relative machinability be judged as a function of the speed at which a chip may be detached from the material by a cutting tool under fixed conditions, the somewhat surprising result emerges that phenolic resins come within the same range as cast iron, in spite of the fact, of course, that they are of considerably lower hardness.

Smaller female threads are commonly produced by tapping, for which purpose exactly dimensioned holes must be provided, either by moulding direct, by drilling, or drilling and reaming.

In Table 3 are given recommendations with regard to allowances on moulded-in holes. Tolerances in the normal series correspond to ISA tolerances JT11. According to the length of the holes and to their position, reaming would appear to be necessary after moulding. In special cases smaller allowances corresponding to ISA JT10 may be applied, but only by special arrangement with the manufacturer, as the smaller tolerances permitted invariably require reaming after moulding, or, in some instances, drilling and reaming. In fact, the double operation is probably advisable for moulded work, owing to the highly abrasive effect on the moulded skin and flash on the fine cutting edges of reamers. The holes, for example, may be moulded under size and either drilled out to reaming size or reamed direct, there being sufficient material for the reamer to get below the skin.

Selecting Tap-drill Sizes

Dimensions of holes to be drilled will, in general, correspond to the general tap-drill size for bronze; this is particularly true in the case of paper or fabric-laminated plastic. For fibre, tap-drill holes 0.002-0.006 in. larger than those recommended for brass and steel are advised. For tap holes to fine tolerances in hard rubber, for threads Nos. 6 to 32, an oversize of 0.002 to 0.003 in. is stipulated, whilst for thread sizes $\frac{3}{8}$-1 in. an oversize 0.006 to 0.01 in. is recommended.

Wide-grooved taps, generally of the two-groove type, are recommended, in that they provide plenty of chip clearance, a necessary feature, as swarf from plastics shows a great tendency to choke the tap.

High-speed steel taps, preferably ground (excepting for very small sizes), are recommended. For reasons given before, sintered carbides would appear to be the most suitable materials from which to produce such taps, but certain technical and economic difficulties hinder the free development of this idea. True, taps above $\frac{3}{8}$ in. diameter may be produced with sintered carbide tips, but the expense of such tools, in consequence of the grinding screw threads, is still prohibitive. Nevertheless, for accuracy and durability such tools are virtually unsurpassable.

For taps below $\frac{7}{8}$ in. diameter, the fixing of a hard metal tip to the already relatively weak shaft of the tap presents great difficulty, for which reason, in the case of certain experimental tools, only the front or rear portion of the tap has been hard-metal tipped, as shown in Fig. 24. The large-scale use of such taps may be envisaged for the main production of plastic parts, as, for example, in the electrical and radio industry.

Through-going holes can generally be cut with a single tap, whereas, for blind holes, a set of two or three taps, as usual for tapping metals, becomes necessary. It should be observed, therefore, that the tapping of blind holes is inherently an expensive operation, quite apart from the extra time consumed in withdrawing the tap.

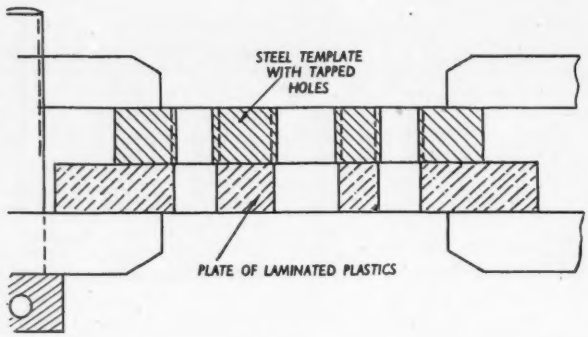
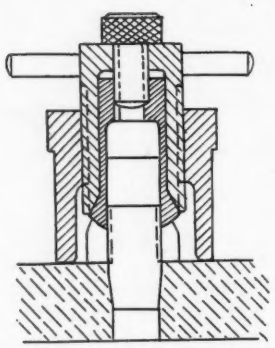


Fig. 25 (left).—Simple threaded template device for production of machine-tapped threads in plastics.

Fig. 26 (below).—Device for locating and guiding tap in the production of threads by machine tapping



As to the pros and cons of machine or hand tapping, no general recommendations can be made, although, for mass production, machine tapping with plant equipped with chasers and reversible friction drive is advised. It is stated that small holes in paper- or fibre-base laminated plastic can be machine tapped at relatively high speeds, e.g., at 200 r.p.m., or somewhat below this for diameters under ¼ in. Medium-sized holes can be tapped at 40-60 r.p.m. in a drill-press fixture.

Continuous Tapping Advised

Contrary to practice customary with metals, it is usually considered advisable with plastics to tap a thread in one continuous operation. If the cut be stopped and restarted several times (a very useful practice, for example, in the case of light alloys, where chip removal is facilitated), the tap often tends to follow along another path, hence threads already produced are damaged or destroyed. Further to avoid this danger, a more sensitive control of the tap must be maintained, and the tool should tend to guide the hand, rather than the hand guide the tool.

In order that tap holes may be exactly located, and to provide a positive guide and feed for the tap, a useful device consists in the employment of a threaded metal template clamped to the workpiece by means of toolmaker's clamps. It should, however, be borne in mind that this method is, in general, applicable only for laminated plastics of small thickness.

In Fig. 26 is illustrated diagrammatically a more elaborate device, which may be placed on the surface of any workpiece and gives, first, exact centring of the tap, and, secondly, provides a guide along the threads. Naturally, the pitch of both threads must be the same.

For machine tapping, the use of plant with a chasing attachment is strongly recommended, more especially for small holes up to $\frac{1}{16}$ in. dia. If possible, neither plain holes nor tapped holes in laminated plastics should run parallel with the laminations themselves (Fig. 27). If this cannot be avoided, however, the material concerned should be clamped between the jaws of a vice, or some similar device employed to prevent separation of the laminations.

The statement has been made in the literature that the production of threads on plastics by means of die heads is unsound practice. For example, in the A.S.M.E. manual on metal cutting it is stated that all machining operations, *with the possible exception of tapping and thread cutting with a die*, may be performed on moulded plastics. Now, although this method is, indeed, seldom employed for moulded plastics, it is, nevertheless, with correctly ground tools and by the stringent observance of certain precautions, possible to cut threads on plastics with a die. The following methods have been successfully employed on a variety of materials.

Solid dies or self-opening die heads should be of such design as to provide adequate chip clearance; flutes should be as deep as possible. Fibre may be cut on capstan lathes with solid dies or self-opening die heads, the only exception being where short lengths are concerned, and, here, threads may be torn off on opening. Smooth threads are obtained by providing the die-head chasers with a negative rake angle of 5-7 degrees. In the case of hard rubber, various authorities have recommended the use of positive or of negative rake angles; it would seem that tools without rake angle most adequately fit the bill.

Where thread production involves only small quantities and where high accuracy must be maintained, the use of the lathe alone is to be recommended. A distinction must be made between the use of the single-point chasing tool fed along the workpiece and the multiple-pointed tool operated only with in-feed.

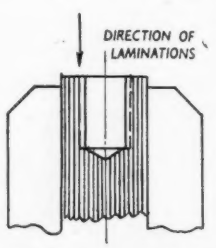


Fig. 27 (above).—If plain or threaded holes in laminated plastics must run parallel to the laminations, material should be tightly clamped, as shown here, to prevent separation.

Hard-metal and Diamond Tools

Owing to the abrasive quality of most fillers, high-speed steel tools have a relatively short life. For single-point tools the use of hard metals or diamond tips is very advantageous. Unfortunately, multiple-point tools with hard-metal tips are extremely expensive, and diamond tools may be regarded as virtually impossible to produce.

Single-point chasers (Fig. 28) are very extensively used. They may be made up in the works by grinding up standard finishing cutters to an included point angle of about 80 to 90 degrees. Before turning threads on moulded parts it is advisable to turn off the skid, which, as has been explained in a previous section of this account, contains the greatest resin content; in this way broken threads and coarsely finished surfaces are avoided.

(To be continued.)

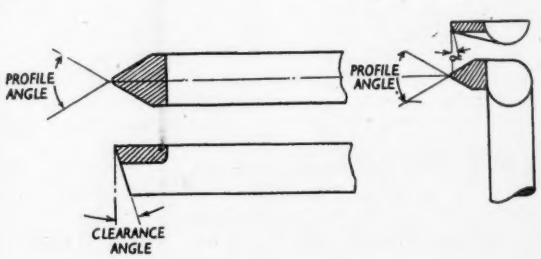



Fig. 28 (right).—At the left of the illustration is shown a typical single-point chaser, whilst at the right is shown deformation of form produced by grinding to an unusual but requisite shape.